भारत सरकार
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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

ब्राड गे ज के डीजल ईलेक्ट्रि क लोको मे प्रयो ग हेतु कम वजन वाले कर्षण मो टरो का तकनीकि विशिष्टिकरण

TECHNICAL SPECIFICATION
FOR
LIGHT WEIGHT TRACTON MOTOR
FOR
BROAD GAUGE DIESEL ELECTRIC LOCOMOTIVES

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TECHNICAL SPECIFICATION FOR LIGHT WEIGHT TRACTON MOTOR FOR BG DIESEL ELECTRIC LOCOMOTIVES

1.1.0 FOREWORD

1.1.1. This specification covers the design, manufacture, testing, supply and commissioning of traction motors with associated parts.

1.1.2. Light weight traction motors are already in use on high speed locomotives. This specification covers traction motors to be used on high speed as well as mixed service locos. The traction motor will be primarily used on WDP2, WDM3C and WDG2 locos.

1.1.3. The current for the traction motors is obtained from traction generator / alternator. The six traction motors on the locomotives will work either in parallel (6P) or series parallel (2S-3P) with or without field weakening (49% FF).

1.1.4. The motor should be suitable for operation with various types/makes of Traction Alternator, details of which are given in clause 3.1.2

1.1.5. The assembled motor offered against this specification shall be freely inter changeable with the existing motors on WDP2, WDM3C and WDG2 locomotives in respect of physical dimensions.

1.2.0 SCOPE

1.2.1 The traction motor shall be supplied complete with pinion, gear wheel, gearcase, roller suspension bearings, connecting lead cables and along with any other accessories that may be required for its correct assembly and commissioning as well as reliability and maintainability on the locomotive. The tenderers shall however indicate the price of pinion, gear wheel, gear case and roller suspension bearing separately.

1.3.0 GOVERNING SPECIFICATION

1.3.1 In preparation of this specification, assistance has been taken from IEC publication 349. The equipment offered under this specification shall generally conform to IEC publication 349 with a specific variation in that, on account of higher ambient temperatures obtainable in India, the temperature rise specified in IEC recommendation shall be suitably reduced.

1.3.2 In case any deviation is proposed from the relevant International Standards or from this specification, the standards followed in the design, manufacture, assembly and testing of these equipment, shall be clearly indicated by the tenderer. In the absence of any such indication, it shall be assumed that the offer complies fully with this specification.

1.3.3 Any deviation from this specification, incorporated by the tenderer to improve the performance, durability, reliability and maintainability of the equipment or to reduce its cost significantly, may be favourably considered provided full particulars of the anticipated benefits along with technical data supported by drawings and calculations, are furnished in the tender offer.

1.3.4 The tenderer will furnish English version of all those standard specifications referred to in their tender offer but not called for in this specification.

1.4.0 SCHEDULE OF PARTICULARS, DRAWINGS AND AS-MADE TRACINGS

1.4.1 The tenderer shall furnish all relevant design data, calculations, technical specifications, test results, and relevant equipment drawings, and descriptive write-up etc. necessary for correct appreciation of the offer. The technical data and motor particulars shall be generally in line with the proforma at **Annexure-5**. As many of these data as would be relevant and applicable should be incorporated in the corresponding drawings themselves.

1.4.2 Complete manufacturing drawings will be supplied, after acceptance of the tender, for the replaceable wearing out components such as armature shafts, commutator, bearing housing, end fittings, brush holders, carbon brushes, rubber components, insulation scheme of armature & field assemblies etc.

1.4.3 The successful tenderer shall prepare and submit to the purchaser complete working drawings in duplicate for scrutiny and approval of the purchaser, i.e. Indian Railways / RDSO, before taking up manufacture of the equipment.

1.4.4 Approval of the drawings would mean approval of general adaptability of design features to local conditions of service. The purchaser, i.e. Indian Railways will not be responsible for the correctness of the dimensions in the drawings, the material used, the adequacy of the designs for the satisfactory performance of the equipment, etc. for which the supplier will be wholly and completely responsible.

1.4.5 Photographs shall be taken at various stages of manufacture and assembly of the traction motor and included in the Maintenance Manuals.

1.4.6 After all drawings have been finalised including any modifications found necessary as a result of prototype testing and trials, five complete sets of 'as made' tracings shall be supplied for use of the Railways and RDSO and shall include full dimensioned drawings of all assemblies, sub-assemblies, component parts including proprietary fittings.

1.4.7 The drawings of the traction motor and components shall be fully detailed and self-explanatory. All-important dimensions shall be figured. The drawings shall contain all essential data, material specifications, explanatory notes including limiting values in service etc.

1.5.0 SPARES AND TOOLS

The successful tenderer shall submit a list of spares required for the operation & maintenance of the traction motors with any accessories as offered by them.

1.6.0 MAINTENANCE MANUALS

1.6.1 Maintenance manuals complete with necessary drawings and photographs for guidance in the installation, operation and maintenance of traction motor shall be supplied free at the rate of one manual for every six traction motors.

1.6.2 Rewinding / Rehabilitation of the traction motors shall be taken up by Railway units whenever necessary after expiry of warranty. Complete technical information shall be provided by the successful tenderer in the form of `Rewinding Manual' for satisfactory rewinding/rehabilitation of the traction motors.

1.6.3 A lubrication chart shall also be enclosed containing the manufacturer's recommendations on indigenously available lubricants, quantity and periodicity of lubricants, etc.

1.7.0 TESTING, COMMISSIONING AND PROTOTYPE TRIALS

1.7.1 The traction motor and its accessories covered by this specification shall be subjected to type and routine tests at the manufacturer's works before shipment / dispatch, in the presence of an Indian Railways' representative, as per a test programme conforming with the RDSO's test programme for traction motors no. MPTP - 034/93. All the tests given in this test programme shall be carried out except in case RDSO is satisfied that a particular test is not required.

1.7.2 Six prototype motors after tests will be first dispatched to examine their correct fitment on the bogies of existing locomotives and any modifications if required will be checked up and carried out accordingly at site.

1.7.3 This locomotive will be subjected to extensive service trials for a period of at least twelve months or more as deemed necessary by the purchaser to prove the design, equipment performance, maintainability and reliability. All modifications found necessary based on these limited service trials to improve upon the motor design and physical construction and as mutually agreed shall be incorporated in the prototypes and in the series supplies of the equipment, at the cost of the supplier and in the manner approved by the purchaser. The service trials shall generally cover the following :-

i) Observations of the mechanical & electrical condition of the equipment including wear and tear.
ii) Temperature rise of the various parts of motor.
iii) Overall reliability and maintainability aspects.

1.7.4 The detailed scheme of prototype trials to satisfy the above, shall be indicated by the supplier and mutually finalised in consultation with the purchaser. Special instrumentation, if any, for correct appreciation of the various data will have to be arranged by the tenderer.

1.7.5 The above tests may, at the discretion of the purchaser, be reduced in scope in case of motors proved under local conditions of service.

1.8.0 MARKING

1.8.1 All the equipment shall bear for identification a serial number and manufacturers' name.

1.9.0 PACKING

1.9.1 The motor shall be suitably packed in wooden waterproof boxes to prevent damage during transit and handling.

1.10.0 WARRANTY

1.10.1 The traction motor shall be guaranteed for satisfactory performance for a period of three years from the date of commissioning. All aspects of workmanship and design shall be covered by this warranty. Only wearing parts, which require recurring replacements shall be excluded. A list of such parts shall be furnished by supplier in this technical offer. This warranty shall include :

i) Replacement of defective components, free of cost by the supplier.
ii) The supplier shall provide free of cost assistance in replacement of defective components / assembly.
iii) Any specialised tools etc. not available with Indian Railways shall be supplied/loaned free of cost by supplier.

2.0.0 CLIMATIC AND ENVIRONMENTAL CONDITIONS

• Maximum temperature(Atmospheric)	Under Sun In shade	70ºC 50ºC
• Reference site conditions	i) Ambient Temp. ii) Humidity iii) Altitude	50ºC 100 % during rainy season 160 m above sea level
• Rainfall	Very heavy in certain areas. The locomotive shall be designed to permit its running at 10 km/h in a flood water level of 10.2 cm above rail level.	
• Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas.	
• Coastal area	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere.	

3.0.0 SYSTEM AND SERVICE CONDITIONS

3.1.0 The traction motor shall be powered by diesel engine driven AC traction generator type BHEL TA10102 CW/DW whose voltage current characteristics(DC link) at full engine power of 3300 HP as given in **Annexure 1**. The motor manufacturer shall match the motor with the alternator and submit the loco Tractive effort vs Speed curve to RDSO for approval before manufacturing the traction motor.

3.1.1 This traction motor is for use on mixed service and high speed passenger locos with engine out put up to 3300 HP. Input to traction will be 2950 H.P. The traction motor connections in the systems shall normally be 2S-3P at start transitioned to 6P FF and then transitioned to 6P WF at a suitable road speed.

3.1.2 The traction motors may also be used on 2600 HP WDM2 locomotives provided with BHEL DC generator 10931, BHEL AC generator 10102 AZ & AY, GE DC generator GT-586 and GE(Canada) AC alternator GTA-11. The representative generator and tractive effort curve for these applications are given in **Annexure 2** and **Annexure 3**. The motor connection in this application involves field weakening also and three transitions are provided changing the motor connections from 2S-3P to 2S-3P WF to 6P to 6P WF. The field is reduced to 49% FF in WF configuration.

3.1.3 Matching of the traction motor with the systems detailed in clauses 3.1.0 & 3.1.1 (passenger version) shall be done so that : –

a) Transition speed can be selected to ensure smooth transition without considerable jerk or current jumps in machines.
b) The motor should be able to achieve maximum operating speed of 160 Km/h with 22: 61 gear ratio and 120 Km/h with 18:65 gear ratio.
c) Continuous locomotive speed is not above 28 km/h.
d) The alternator current does not exceed 3700 amps. at any speed above the continuous speed especially at the backward transition stage.

3.1.4 The motor shall be designed for operation with pulsating current (rectified three phase alternating current) with a ripple factor of 5 - 6%

3.2.0 The general temperature of the cooling air at the inlet of the traction motor shall be 50ºC maximum with relative humidity varying upto 100% saturation.

3.3.0 The equipment and mounting arrangement shall be of the robust design for traction duty and shall withstand satisfactorily vibrations and shocks normally encountered in traction service as indicated below :

Maximum vertical acceleration - 1.0 g
Maximum longitudinal acceleration - 3.0 g
Maximum transverse acceleration - 0.5 g

3.4.0 The diameter of the wheel when new is 1092 mm & when worn fully is 1016 mm.

3.5.0 The maximum service speed of the locomotive may be used is 140 km/h. However, the motor offered should be mechanically and electrically capable of trouble free operation upto a service speed of 160 km/h and test speed of 176 km/h. The optimum gear ratio required for this application shall be indicated and offer submitted for pinion and gear wheel accordingly (existing gear ratio for high speed locomotive is 22:61).

Also, the motor should be suitable to be used on mixed service locos of maximum speed of 120 Km/h at 18:65 gear ratio. The motor should be able to achieve test speed of 132 Km/h with this gear ratio. The maximum starting tractive effort on these locos will be 39.0 Tonnes.

3.6.0 The motor weight complete with pinion, gear wheel, suspension bearing and gearcase shall not exceed 3175 kg.

3.7.0 Forced ventilation Air quantity of 65 m cube/min. at 50ºC maximum is available for cooling each traction motor assuming 93 mm WG pressure drop in the traction motor at this flow.

3.8.0 The motor shall be designed and manufactured for fitment on High adhesion, Flexi - coil and trimount co-co bogies used on BG Diesel-Electric locomotives. Drawings for mounting details and nose suspension on bogie, wheel axle set, traction gear wheel and pinion as used on BG Diesel-Electric Locomotives are detailed in **Annexure 4**. Minimum rail clearance will be 140 mm with new wheels and 102 mm with fully worn wheel with tilting of gear case. The nose suspension to be provided on the motor shall be accommodated within the existing lugs/brackets provided on the bogie transom without any changes or modifications.

3.8.1 The motor bearing housing and sealing arrangement should be designed in such a way that , greasing periodicity is not less than 3 years. The motors will be re greased only during overhaul, which normally varies between 3 to 3½ years.

3.8.2 The motor offered shall be interchangeable with existing traction motor on the existing WDM2 and WDM2C / WDG2 locomotives.

3.8.3 The tenderer may, however, also offer a motor of a superior design, which may not be fully interchangeable but would fit on the existing locomotive, to be powered from the existing traction equipment without any modification in the existing wheel set.

3.8.4 The tenderer may offer a standard and well-proven motor, which is in current production. Full particulars regarding the number of units in service and present application rating should be submitted for such a motor.

4.0.0 DESIGN, MATERIALS AND RATING

4.1.0 GENERAL

4.1.1 The materials used as insulation for the components shall be non-combustible and non-hygroscopic and shall withstand the service conditions specified.

4.1.2 Standard metric hardware shall be provided.

4.1.3 All nuts and screws shall be securely locked and shall not loosen in service due to the excessive vibrations to be met in service.

4.1.4 All components including bolts, nuts, washers and screws etc., shall be suitably protected against corrosion and rust.

4.1.5 All locations such as gearcase suspension, suspension bearing fixture, end shield fixation, nose suspension sandwich block fitment etc., adequate material should be available or suitable anti-wear replaceable bushes should be used to either minimise wear or permit future building up for restoring these surfaces or replacement of the bushes etc.

4.1.6 Wherever welding is done, the welded portion will be finally ground off to give a smooth finish and to remove the notch effect at the toes of the welds. Fillet welds as far as possible would be avoided and butt-welding shall be preferred.

4.1.7 All normal wearing and consumable items such as carbon brushes, armature roller bearing greases, roller suspension bearing greases, gear case compound, etc. shall be selected to the same grades/specifications as are already in use on the existing stocks on Indian Railways.

4.1.8 Clearances and creepage distances shall conform to the values given in table below. In case it may not be possible to comply with these values at some locations due to restriction of space etc., adequate insulation shall be provided at such locations. Use of protective coatings such as varnishes etc., shall not warrant reduced clearances and creepage distances.

4.1.9 A suitable earthing cable shall be provided.

CLEARANCE AND CREEPAGE DISTANCES

	Air clearance	**Creepage distance**
Clean	15	40
Dirty	25	55

4.1.10 No contact pressure shall be transmitted through insulating materials and the gripping of the conductors shall normally take place between metal surfaces.

4.1.11 Lifting Arrangement : Suitable hooks for lifting the motor with crane shall be provided.

4.2.0 SPECIFICATIONS FOR DESIGN

4.2.1 In addition to IEC-349 following is the list of Standards referred to in this specification for design and performance of the traction motor :

IEC 50	Definition terminology
IEC 216 (I & II)	Guide for the determination of thermal endurance properties of electrical insulating materials, Parts I & II.
IEC 349	Rules for rotating electrical machines for rail and road vehicles.

IEC 505	Guide for the evaluation and identification of insulation systems of electrical equipment.
IEC 563	Permissible limiting temperature in service for components of electrical equipment of traction vehicles.
IEC 165/1963	Rules for the testing of electric rolling stock on completion of construction and before entry into service.
IEEE-11	American standard for rotating electric machinery.
IEEE304	IEEE test procedure for evaluation and classification of insulation system for DC machines.
IEC 356/1971	Dimensions for commutators and slip rings.
IEEE 429	Test procedure for the revaluation of sealed insulation systems for AC electric machinery employing form wound stator coils
IEC 368	Commutation index.

- IEC is International Electro-technical commission.
- IEEE is Institute of Electrical and Electronics Engineers, USA

4.3.0 RATING

4.3.1 The rating of the motor shall be adequate to meet the performance requirements detailed in clause 3.1.5 but in no case shall be less than the rating given in clause 4.3.2 to 4.3.6.

4.3.2 Low Voltage Current Rating :

	Voltage(V)	Current(Amps.)
Continuous	350	925
One hour	325	950

4.3.3 High Voltage Rating : FF 1125V at maximum service speed
WF 900 V at maximum service speed

4.3.4 Efficiency : Efficiency of the traction motor with gearing shall be same as or better than the efficiency of existing 5002/7362 traction motor.

4.3.5 Maximum starting current : 1400 Amps. for 2 minutes duration.

4.3.6 Insulation Level : The motor insulation level will be provided for 1200 V between power to ground.

4.4.0 INSULATION SYSTEM

4.4.1 Modified class 200 insulation scheme shall be used on these motors.

4.4.2 The insulation scheme will continue to employ polyester resin as at present. Hitachi or Permacel or equivalent materials modified to in respect of changing to Silicone resins instead of multi-functional / tri-functional epoxy – shall be used. The insulating materials proposed to be used shall be got approved by RDSO.

4.4.3 Modified class 200 insulation scheme shall conform to RDSO drawing no. SKDP-3559 (compole coil), SKDP-3563 (main field coil) & SKDP-3564 (armature coil)

4.4.4 The armature and field coils shall be vacuum-pressure impregnated with solvent less resin. Armature and field coils should be provided with suitable moisture impervious sealing insulation. Kapton covered heat-sealed conductors for both main as well as equalizing coils shall be used on the armatures.

4.4.5 Roll baking of the armature shall be done during cure. The insulation on magnet frame shall be provided preferably by VPI or Flood-Dipping with solvent less resin of the magnet frame complete assembled with field coils prepared as in clause 4.4.3.The coil insulation shall be pressure moulded in such a manner that the exact coil contour is achieved. The field coil surface mating with the pole shoe shall be provided with a smooth surface by special treatment during moulding or otherwise to ensure proper heat transfer to the pole shoes.

4.4.6 The armature and the field coil shall be given an anti tracking coat by spray application of a suitable furnishing varnish to obtain a smooth surface.

4.4.7 The maximum electric stress in the armature and field coils in service shall be well below the corona inception voltage.

4.4.8 The insulation system to be employed shall be particularly designed to withstand the adverse environmental conditions. The materials comprising this system and preferably the system itself shall have been proved to be of the highest reliability in traction application.

4.4.9 The evaluation of the insulation system for thermal endurance shall be made with fabricated test models by way of accelerated ageing tests as per the test programme drawn up in accordance with the norms specified in IEC 505 & IEEE 304. The value of the proof voltage for electric test prescribed in IEEE 304 for determining the end point after each ageing cycle shall correspond to 85% of the dielectric test voltage on new machine prescribed in IEC 349 & NOT 2E as laid down in IEEE 304.Ealuation of insulation system for sealing against moisture shall be done in accordance with IEEE 429.

4.4.10 Various ageing parameters, such as heat, vibration, mechanical/compressive stresses, special environmental effects of humidity, dust, metallic dust from brake shoes, etc, will be incorporated to simulate the actual working conditions as closely as possible.

4.4.11 The temperature at which an extrapolated life of 20,000 hours is obtained shall be treated as the thermal endurance limit (Temperature Index) of the insulation system.

4.4.12 The exact test programme and agency employed for evaluation of insulation system followed by the tenderer shall be indicated along with the offer.

4.4.13 Having regard to the system of insulation adopted and the environmental conditions, the manufacturer shall provide maximum possible margins in temperature rise, for prolonged life of the traction motors.

4.4.14 The temperature rise of traction motors during type/routine tests shall be limited to the following, it being clearly understood that no motor exceeds these limits :

- Permissible temperature rise :- Tia minus 90ºC on armature windings by resistance method.
- Permissible temperature rise :- Tif minus 70ºC on field winding by resistance method.
- Permissible temperature rise :- 85ºC on commutator.

Where, **Tia** is the established Temperature Index for the armature insulation system. **Tif** is the established Temperature Index for the field insulation system as determined by tests prescribed above.

4.4.15 The motor shall be designed such that the "hot spot" temperature under any condition of loading in any winding(armature or field) remains at least 25ºC below the thermal endurance limit.

4.4.16 Alternatively, if the tenderer offers a motor with a proven insulation scheme for which the determination of temperature index has not been done, the temperature rise shall be limited to :-

- IEC-349 minus 30ºC for armature windings
- IEC-349 minus 20ºC for field windings
- 85ºC for commutator

The evaluation of the insulation system in this case shall be completed within a specific time frame decided mutually between the successful tenderer and the purchaser. The temperature rise limit shall be limited to those given in clause 4.4.11 after determination of the temperature index.

4.4.17 Special protection shall be taken in strengthening the insulation, electrically and mechanically, at bends of the coils and edges of slot etc. For approximate 50 mm zone behind the commutator risers, special insulation with high electrical and mechanical strength shall be provided at the transition bend of the coils, taking steps to ensure that this insulation is not affected during the banding process. The insulation level in this region of 50 mm behind the commutator riser would in any case be not less than 120% of the inter turn puncture voltage in the slot portion.

4.4.17.1 The overhang portion of the coil shall not only be reinforced at the coil noses and bends behind the commutator risers but the complete coil overhangs shall be additionally insulated.

4.5.0 ARMATURE AND COMMUTATOR ASSEMBLY

4.5.1 The armature core shall be built of high permeability steel laminations assembled with an interference fit on the armature shaft. The laminations shall be securely clamped between thick end plates, which shall also act as supports for the winding overhangs. The end plates shall have stepped-back design to facilitate the use of U-piece in the slot to avoid mechanical damage of the coil insulation.

4.5.2 The commutator shall be of arch bound construction manufactured from cold rolled/cold drawn bars of electrolytic copper alloy to IS : 5885 or equivalent material with special provision that its silver content shall be in the range of 0.08 to 0.15 and its surface hardness shall be such that the commutator has a surface hardness of 95 HV after dynamic seasoning.

4.5.2.1 The armature - commutator assembly would be dynamically balanced such that the residual unbalance is not more than 1.5 gram meter.

4.5.2.2 Suitable arrangement like pocket in the end plates for filling with lead, shall be provided for dynamic balancing of the complete unwound armature assembly. The balancing of the armature after winding shall be done by means of adjustable weight in grooves at the end of the armature.

4.5.3 Res-i-glass banding shall be provided. Full details of the banding procedure will be furnished.

4.5.4 Tolerances on dimensions of the commutator shall be as per IEC 356/1971.

4.5.5 Commutator manufacturing process shall include, at the stage of assembly and consolidation of copper segments and insulating separators, an adequate number of static seasoning cycles comprising cold tightening of assembly fixture, heating for not less than 4 hours at a temperature not less than 160ºC. and hot tightening before matching of V- groove .Static seasoning shall be followed by suitable dynamic seasoning of the commutator with precise temperature control.

4.5.6 The armature and commutator assembly shall be so mounted on the armature shaft so as to facilitate reshafting, during maintenance, without disturbing the armature windings and commutator connections.

4.5.6.1 Similarly it should be possible to remove and replace the commutator assembly from the shaft as a unit in itself without disturbing the armature core & winding etc.

4.5.7 The V-ring shall be clamped to the commutator bars with fasteners such as to provide adequate arching pressure to retain the bars under all conditions of operation. The clamping bolts shall be securely locked after completion of seasoning cycle and tensioning of the bolts to the required torque.

4.5.8 Flat rectangular or square section conductors shall be used for equaliser connections, which shall be done for 100% equalisation. The equliser windings shall be fitted behind the commutator risers and securely glass banded in place before fitting the main windings.

4.5.9 Moulded plastic wedges shall be used, whose properties shall not change appreciably upto 200ºC.

4.5.10 The commutator shall have a safe wearing depth of 12.5mm minimum, measured radially on the radius to allow for a sufficient number of resurfacing operations.

4.5.11 TIG welding of the conductor to commutator shall be adopted. The width of the risers shall not be less than 20 mm.

4.5.12 The exposed V-ring shall be covered with an 'L' shaped PTFE sleeve which shall be fixed in position using an expander. A suitable adhesion shall be used to retain the sleeve in position.

4.5.13 Armature shaft material shall conform to :

a) Indian standard IS : 5517 - 1978,
Designation 31Ni10Cr3Mo6, Type - D

OR

b) British standard BS : 970 Part 2-1970
Designation 826M31, Condition `V'

4.5.14 The design of the armature shaft and the armature core bore shall be such as to permit reshafting without damage to core or windings.

4.5.15 The surface finish on the shaft shall be :

a) Pinion end upto armature core seat - 1.0 micron CLA min.
b) Other locations - 3.0 micron CLA min.

4.6.0 ARMATURE BEARINGS

4.6.1 The armature shall be mounted on anti friction roller bearings of standard make and dimensions. The bearings shall be of sealed type, which shall not require replacement of grease for three years.

4.6.2 The bearings shall have the basic life rating L10, as calculated vide ISO 281 recommendation, of at least 2 million kms. (ISO - International Standards Organisation)

4.6.3 Provided that the static and dynamic loadings are well within the permissible limits, the roller bearings type NH 318 and NU 328 respectively for the commutator and pinion ends, both with C4 radial clearances should be adopted for the motor. Bearings used on pinion end should be of **rivetless cage** type.

4.6.4 Maximum permissible speed of the armature shall not exceed the catalogue limiting speed of the bearing. The rolling elements and greasing arrangement will be so designed that the working temperature of the bearings shall be well within the catalogued limits under worst operating conditions.

4.6.5 The lubricant to be used shall be indigenously available.

4.6.6 Provision of roller guided rivetless bearings with cylindrical cage pocket profile shall be preferred.

4.6.7 A built in safe guard in the design of bearing housings to prevent over greasing shall be preferred.

4.7.0 MAGNET FRAME & FIELD COILS

4.7.1 The main pole shall be laminated. The optimum compole tip profile and compole air gape shall be fixed after intensive commutation and black band testing.

4.7.2 The field coils shall be placed around pole cores with minimum of overhang on the sides.

4.7.3 The main field and commutator field interconnectors shall be brazed with silver solder.

4.7.4 The field-to-field connections may be provided with rigid copper bus bar, but all connections to and from the brush boxes, shall be with flexible cables.

4.7.5 The support points of inter connections shall be provided with 50% higher ground insulation level than that on field coils.

4.7.6 The field coil connectors shall be firmly supported by tying with glass fibre cord etc., to suitable projecting clamps fixed to the stator inside surface.

4.7.7 Compensating windings for the main field may be provided with advantage, from the point of view of having better commutation, avoiding flashover and ensuring better stability. Provision of compensating winding should also result in smaller main and inter pole coil.

4.7.8 The design of interpole coils shall be such as to avoid distortion of the coils during flashover. The center section of the coil may be banded overall with high tensile glass tape if felt necessary for this purpose.

4.7.9 Fabricated steel lightweight end fittings for the frame on both pinion end and commutator end shall be preferred.

4.7.10 Air inlet flange matching with the existing WDP2 locomotive arrangement shall be provided on the commutator end. The cooling air shall flow through axial holes in the commutator hubs and armature core before being let out through out let openings provided in the end shield on pinion end.

4.7.11 Existing lightweight traction motor Junction Box will have to be relocated to suit high adhesion bogies. If the junction box relocation is not feasible, than lead cables shall be provided in lieu of junction box. Provision of Junction Box/ lead cables has to be finalised in consultation with RDSO before taking up manufacturing of the traction motor.

4.8.0 BRUSH GEAR

4.8.1 The brush holder provided in the motor shall be **Reaction Type** and generally conform to RDSO specification no. MP.0.2400.04. Any deviations from this specification to improve the performance of the brush gear on the motor offered shall be acceptable.

4.8.2 The brush box design shall be such that the brushes are staggered to cover the entire working length of the commutator to avoid grooving.

4.8.3 Brush holder spring shall be conical spiral type such that the spring pressure remains fairly constant over the entire working length of the brushes.

4.8.4 It shall be possible to remove and refit the brushes easily during inspections. Separate spring rests will be included to hook the spring in released position for attending to the brushes. The spring shall be simple and spiral type.

4.8.5 Carbon brushes of the following grades shall be used :

- ACPL - EG 14 D(I)
- Le Carbone - EG 6754 & EG 7097

4.8.6 Adjustable spark studs/rings will be provided between the brush boxes and the adjacent stator frame. These sparking studs/rings will also be replaceable.

4.8.7 The brush holder mounting stud shall be rigidly attached to the magnet frame. The mounting stud shall be of Mycalex type and provided with PTFE insulation to give the necessary protection against creepage to earth. The mounting of the brush holder on stud shall be such as to maintain it square against the commutator in all conditions. Suitable provision for radial adjustment of the brush holder to correct for commutator wear shall be provided.

4.9.0 CABLES

4.9.1 The traction motors shall be provided with four lead cables, two for armature and compole and two for the main field, which shall be terminated in a terminal box mounted on the stator and suitably sealed at cable entry/exit points with RTV compound. Fluonlex type cables (conforming to RDSO specification no.MP.0.5200.05,Rev.-2) of 150 mm² and 80 mm² size shall be used as lead and brush gear interconnector cables respectively.

4.9.2 The lead cables shall be taken out from the magnet frame through suitable nylon/rubber bushes and secured in a RIDL (Reinforced Densified Laminated) wooden cleat mounted on the frame.

4.9.3 Heat Shrinkable Tubings of M/s Raychem or any other imported one shall only be used over the cable joints.

4.10.0 SUSPENSION BEARING

4.10.1 Taper roller suspension bearings of an approved make and designation as detailed below shall be provided in a U-tube type arrangement.

Roller Suspension Bearing

S.No	Make	Road Wheel End	Gear Wheel End
1.	TIMKEN	TS M 349547-M 349510	TS M 249747-M 249710
2.	FAG	FAG 547734	FAG 547733
3.	SKF	M 349547/ 510	M 249747 / 710

4.11.0 COMMUTATOR INSPECTION COVER

4.11.1 Light weight flat inspection covers shall be provided.

4.11.2 The top inspection covers shall be of spring latch hinged and the bottom one of screwed type.

4.11.3 At the inspection cover opening of the stator, a raised border will be provided all round to guard against any water dropping into the commutator chamber. Inspection cover shall be of waterproof construction.

4.12.0 GEAR WHEEL, PINION & GEAR CASE

4.12.1 The gear wheel & pinion shall conform to RDSO drawing no. SKDP-3419 & 3312 with 22:61 gear ratio for passenger version, SKDP-3623 & 3624 with 18:65 gear ratio for mixed service version of diesel electric locomotives.

4.12.2 Gear case fabricated from MS sheets/FRP shall be of leak proof design. Although the gear case shall be used as a matched set, interchangeability of upper and lower halves should be possible.

4.12.3 The gear case shall be mounted in position preferably by direct screwing into lugs integral with the magnet frame end shields. Fixing of gear case by screwing into bosses welded to gear case should be avoided as far as possible.

4.12.4 Access to various fixation bolts should be possible in a pit and these should be conveniently located for tightening and checking. It should be possible to inspect the gear and pinion by dropping the bottom portion of the gear case without recourse to lifting of the locomotive.

4.12.5 The compound-filling opening on the gear case shall be provided on the lower half. The cover shall have a spring-loaded cover.

4.12.6 The dipstick for checking lubricant level will be suitably bent to measure the level towards the middle of the gear case instead of checking it at the end pockets. The dipstick shall be chained to the gear case exterior and a breather shall also be provided.

4.12.7 PTFE seals as per RDSO drawing no. SK.DP - 3448 shall be employed in the wheel side grooves of the gear case to arrest the ingress of filling compound.

4.13.0 APPROVED VENDORS

Traction motor armature bearings, suspension bearings and materials used in modified class 200 insulation scheme, cables and cable leads, MSU tube and components shall be procured only from RDSO approved sources.

4.14.0 QUALITY ASSURANCE PLAN (QAP)

The said QAP shall be specifically approved by RDSO before undertaking manufacture of the traction motors.

4.15.0 MARKING/RATING PLATE

4.15.1 Each motor shall be provided with a suitable rating plate giving usual information including the following :

- Manufacturer's name
- Type and serial number of stator and armature.
- Rated voltage.
- Rated current.
- Speed.
- Insulation .
- Date of manufacture.
- Rated KW/HP.(Input)
- Rated shaft KW/HP.(Input)

4.15.2 The rating plate shall be clearly visible when the motor is installed in position.

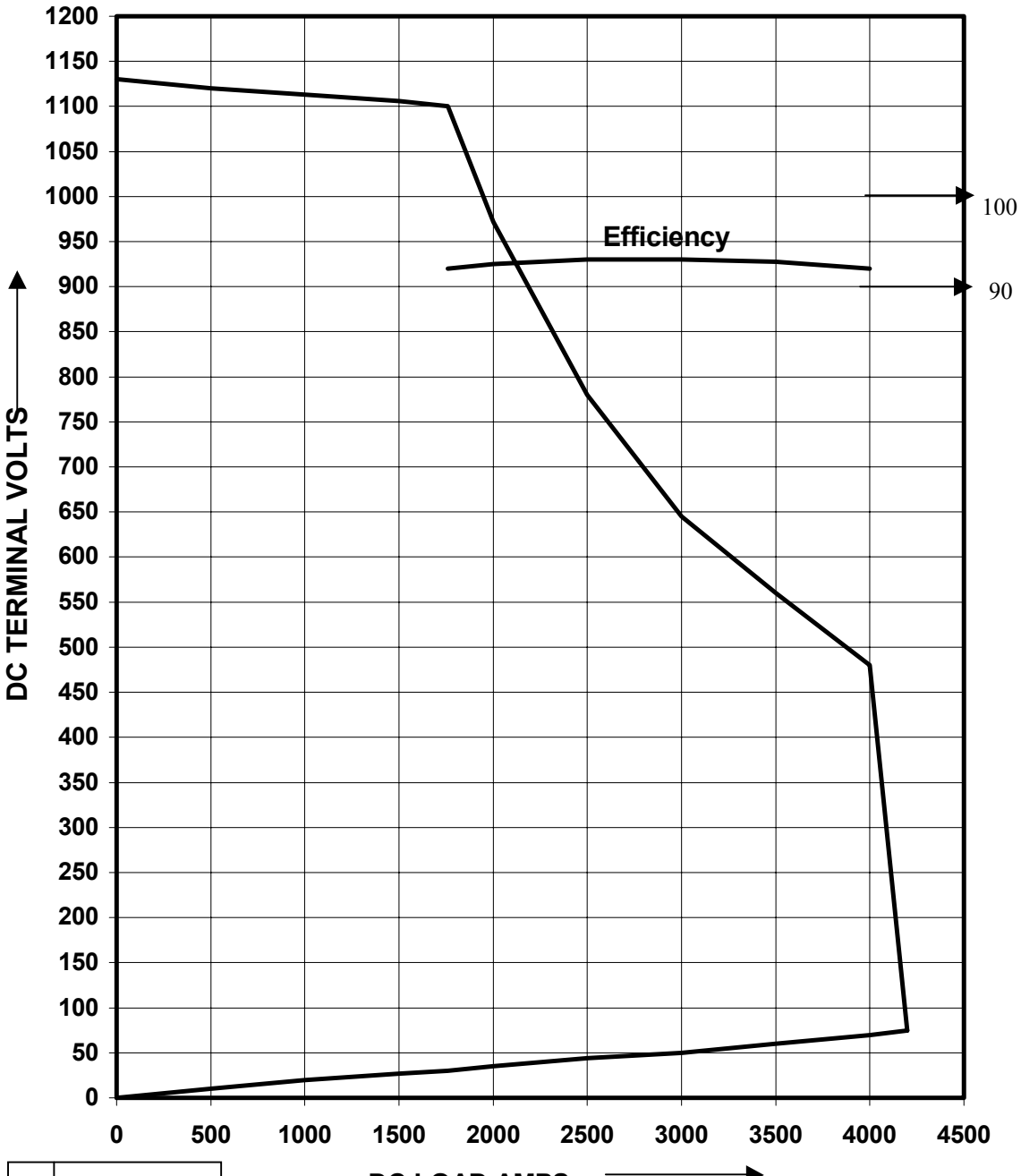
4.15.3 Identification numbers shall also be suitably stamped on non-interchangeable matched components to facilitate assembly and to prevent mixing up.

TRACTION ALTERNATOR TA10102 DW CHARACTERISTICS

INPUT TO TRACTION : 2950 HP AT 1050 RPM

HV CONT. RATING : 1100V, 1760A, 1936KW, 1050RPM

LV CONT. RATING : 525V, 3700A, 1942.5KW, 1050RPM



D	CDA/EM
C	CDA/EM
APPD. DIR/EM	

REF : BHEL CURVE No. TME/401284

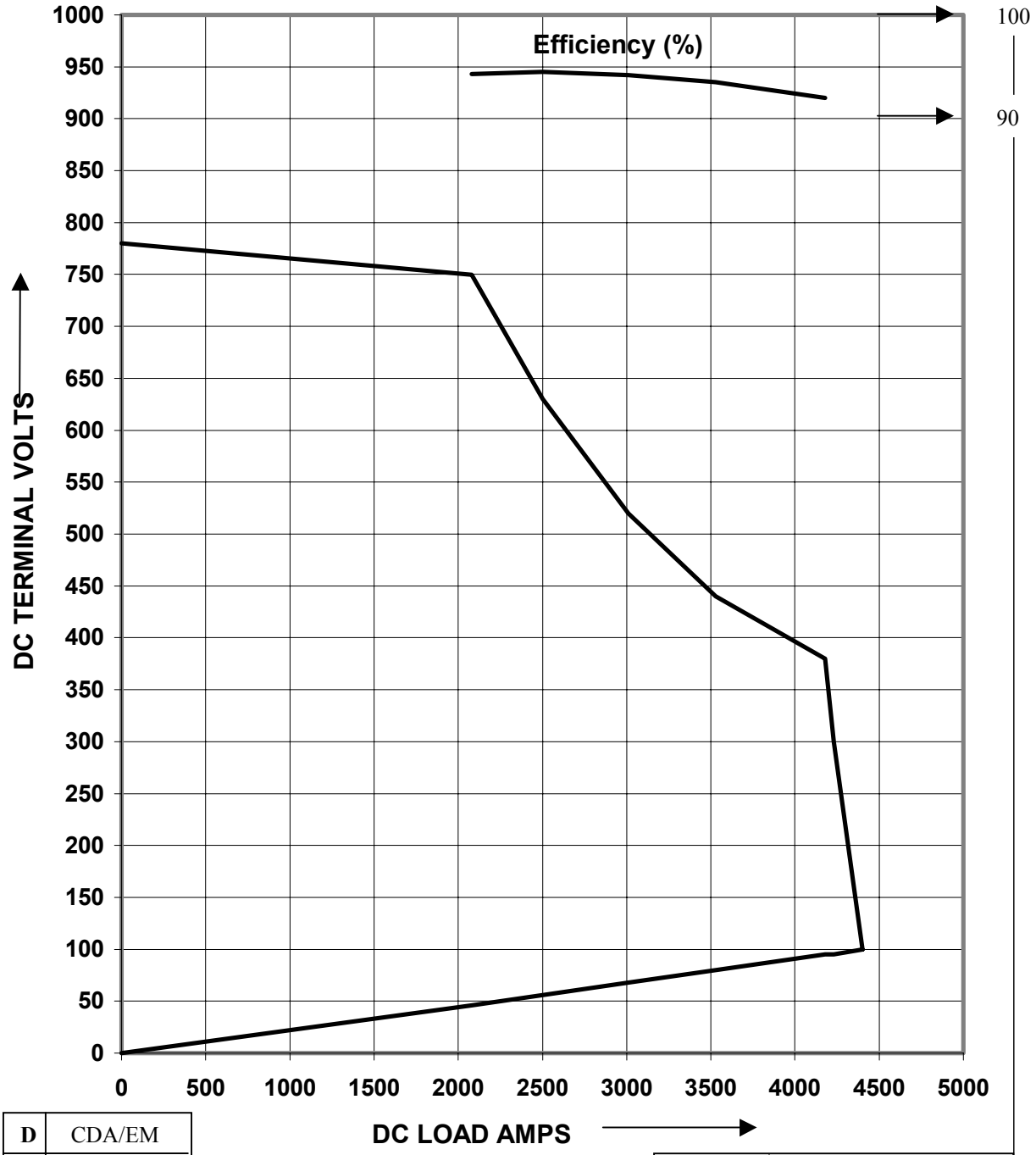
RDSO (MP)	**GDP - 1128**

TRACTION GENERATOR TG10931AZ/M CHARACTERISTICS

INPUT TO TRACTION : 2250 HP AT 1000 RPM

HV CONT. RATING : 750V, 2250A, 1687.5KW, 1000RPM

LV CONT. RATING : 525V, 3200A, 1680KW, 1000RPM



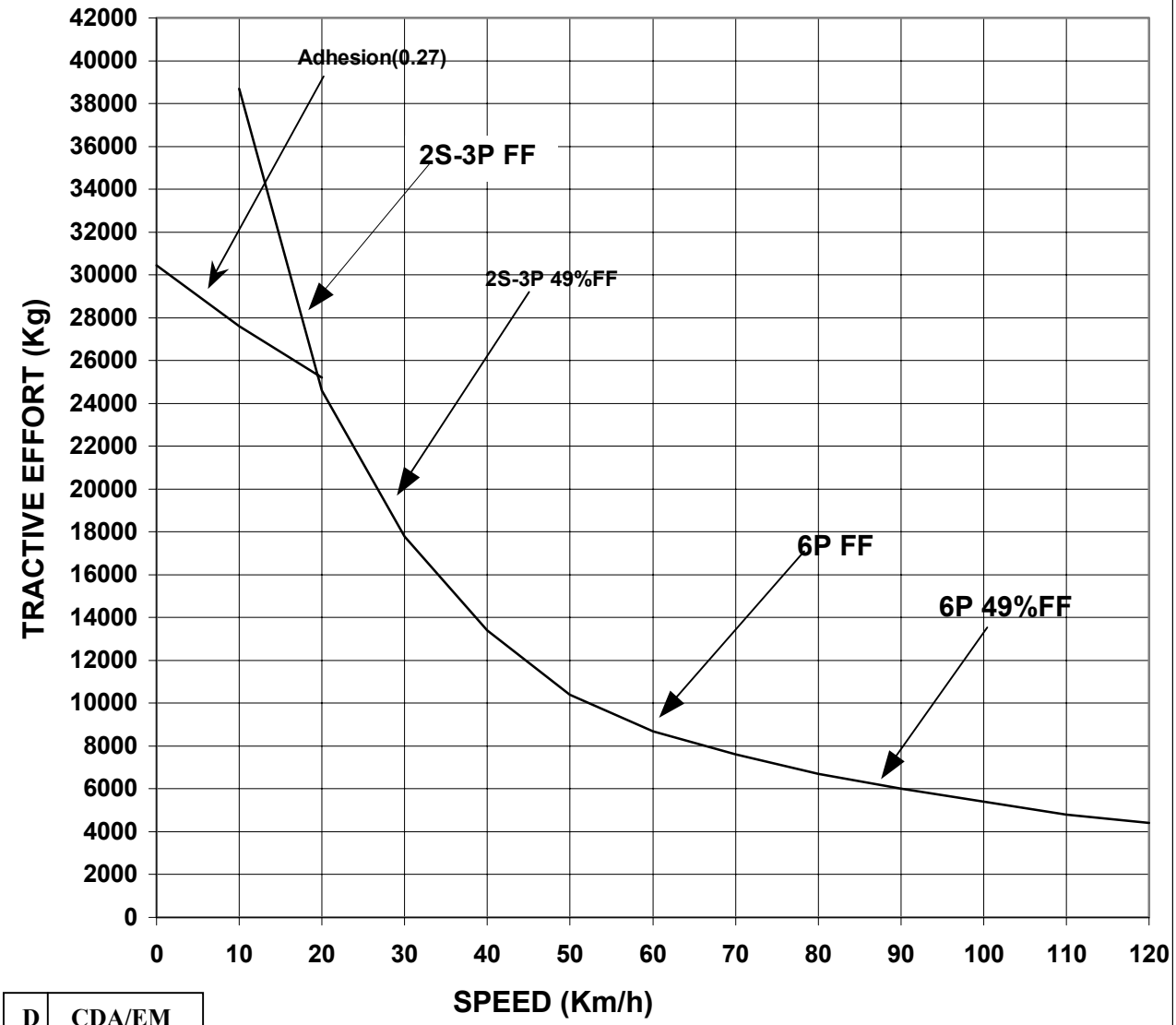
D	CDA/EM
C	CDA/EM
APPD. DIR/EM	

RDSO (MP)	REF : BHEL CURVE No. TME/400213E
	GDP - 1129

SPEED Vs TRACTIVE EFFORT CHARACTERISTICS
WDM2 (DC-DC) BG DE CO-CO LOCOMOTIVE

2250 hp Input to traction (site condition)

1 - TG 10931 AZ Traction Generator, 6 - TM 165M Traction Motor
Wheel Dia. (Half Worn) - 1055 mm, Gear Ratio - 18:65
Motor Combination - 2S-3P FF, 2S-3P 49%FF, 6P FF, 6P 49%FF
1st Transition : 29 Km/h **Cont. Loco Speed : 19.7 km/h**
2nd Transition : 47 Km/h **Cont. Loco TE : 24000 Kg**
3rd Transition : 82 Km/h



D	CDA/EM
C	CDA/EM
APPD	DIR/EM

RDSO (MP)	REF-
	GDP - 1083

WDP2 LOCOMOTIVE

S.NO	DESCRIPTION	DRAWING No.
1.	WDP2 Axle showing motor axle bearing seat	RDSO Drg.No :- VL.FMS – f.02
2.	61 teeth gearwheel used on WDP2 locos	RDSO Drg.No.- SKDP-3419
3.	22 teeth pinion used on WDP2 locos	RDSO Drg.No.- SKDP-3312
4.	Bogie frame arrangement	VL.FM5 – b.01
5.	Details of nose suspension	RDSO Drg.No.- 412V / 98770

WDG2/WDM3C LOCOMOTIVE

S.NO	DESCRIPTION	DRAWING No.
1.	WDM3C Axle showing motor axle bearing seat	RDSO Drg.No :- 53.05.01
2.	65 teeth gearwheel used on WDM3C locos	RDSO Drg.No.- SKDP-3623
3.	18 teeth pinion used on WDM3C locos	RDSO Drg.No.- SKDP-3624
4.	Mounting dimensions for traction motor on BG CO - CO bogie	RDSO Drg.No.- 53.04.02
5.	Details of nose suspension	RDSO Drg.No.- 412V / 98770

TRACTION MOTOR DATA

The following data / information shall be supplied :

1. Exact description of motor (make & type)
2. Verification
3. Maximum design rating
   - Maximum permissible speed
   - Maximum voltage
   - Maximum current
   - Maximum input power(for 1000V application)
4. 3100 HP Application Rating
   - Rating (low voltage) :
     - One hour : Voltage, current ,shaft horse power and speed.
     - Continuous : Voltage, current ,shaft horse power and speed.
   - Rating (high voltage) :
     - One hour : Voltage, current ,shaft horse power and speed.
     - Continuous : Voltage, current ,shaft horse power and speed.
   - Maximum starting current and its duration
5. Class and type of insulation :
   - Armature
   - Field
   - Commutator
6. Resistance at 25ºC :
   - Field
   - Armature
6. Brush gear :
   i) No. of brush holders
   Type : Radial / Trailing / Reaction
   ii) Brushes per holder
   iii) Pressure :
   a) Max.
   b) Min.
   iv) Size of brush
   v) Min. height
   vi) Holder clearance to commutator
   vii) Grade of brush
   viii) Clearance between brush and brush holder

8. Armature
   i) Overall dimensions
   ii) Winding details - type, conductor size turns/coil, material and pitch
   iii) Binding details
   iv) No.of slots & size
   v) Equaliser winding details - conductor size, pitch, material, etc.

8.1 Armature Shaft & Bearing

i) Shaft material and finish
ii) Com. End bearing type_____make_____grease_____
iii) Pinion end bearing type_____ make_____grease_____

9. Commutator

i) Overall dimensions
ii) No. of commutator segments & size
iii) Side mica thickness
iv) Groove width ‘
v) Max. permissible run out
vi) Material & size of V-ring
vii) Fixing detail of V-ring
viii) Commutator riser width

10. Type of suspension

i) Lateral clearance Max. & Min.
ii) Radial clearance Max. & Min.
iii) Lining thickness

11. Magnetic frame

i) Overall dimensions
ii) No. of poles & bore size
iii) Air gap at :
a) exciting pole
b) Com. Pole

12. Cooling

i) Air quantity
ii) Inlet static pressure in commutator chamber

13. Weight

i) Complete unit with accessories
ii) Motor only
iii) Armature
iv) Pinion
v) Gear
vi) Gear case

14. Characteristic curve

i) Torque, speed, voltage & efficiency vs load (FF & WF)
ii) Back e.m.f./rpm vs.current curve
iii) No load saturation

15. Tests :

Results of type test & routine test as per test programme.

- Type test :
  a) Measurement of cold resistance & temperature
  b) Temp. rise test and calculations

c) Characteristic curves
d) Commutation test
e) Starting test
f) Black band test
g) Airflow/Headloss characteristics
h) Over speed test
i) Calibrating ventilation
j) D. E. test
k) Starting test
l) Interruption test
m) Measurement of no load losses

- Routine test :

a) Temp.rise test
b) Over speed test
c) Dielectric test.
d) Characteristics test
e) Commutation test

16. Calculations

a) Estimated temp. rise at LV cont. rating/thermal time constant
b) Reactance voltage at LV and HV rating points
c) Critical speed

17. Drawings

a) Outline longitudinal & cross sectional drawings of the motor
b) Assembly drawing of the motor
c) Mounting arrangement of the motor with details of nose suspension.
d) Brush box assembly and details of arcing studs and carbon brush holder arrangement including brush holder connecting cable layout.
e) Detailed drawing showing insulation schemes for armature coil, main pole & interpole coil and equaliser coil.
f) Mounting drawings of interpole and mainpole.
g) Main and compole coil connection layout.

18. Material Specification

a) Slot wedge
b) Res-i-glass
c) Anti creepage band
d) Lead cable
e) Brush holder
f) Felt lubricator
g) Suspension bearing dust guard
h) Armature stampings
i) Main field stampings
j) Yoke and compole steel
k) Suspension bearing
l) Gear/Pinion
m) Armature shaft